Android-Powered Head Unit

Assignment 7

Engineering Design VI, Spring 2013

Patrick Jan Gregory Kaminski Frank Mischin Justin Rue

Project Overview

Our project is to build and program a navigation/head unit for a car that is developed using the Android mobile operating system. The head unit will be developed using a tablet as well as other hardware to allow it to communicate with the car. It would be wired into the car's 12V outlet to receive power, the car's antenna to use for data signal, the car's stereo for audio signal, and the car's OBDII port for vehicle information. The head unit will be able to receive diagnostic information from the car's OBDII, and project it into an application so that information can be read and viewed easily by the user. This can be used to show problems with the car, as well as performance items such as gas mileage, oil temperature, tire pressure, speed, and tuning information. As well as being able to read information from the car, you can also use this interface to listen to music and use GPS for navigation. The head unit will be developed in a way that will allow it to be removed from the car. This will allow you to use this head unit as a stand-alone tablet, and also provides added security to avoid theft. It also allows for third-party outside analysis of performance data, if desired.

Background Information

This project revolves around the use of an Android powered device. In order for this project to be successful, we will need to be able to create an application that can be run effectively on the Android platform. Android is a great tool to use because it is open source. This is beneficial because the android programming community is very large, so plenty of help and resources are available. However, it is limiting in the sense that we have to use a Java programming language, as well as using Eclipse for the IDE and compiler. The Android environment is a good choice because when the application is installed, it only has access to the resources needed to run the application. This makes the environment secure and safe.

In order to work hand-in-hand with the Android OS and UI, we have decided to utilize the On-board Diagnostic (OBD) port present in all modern automobiles. Use of this port provides the primary benefit of a unified standard, which means this functionality can be implemented in any cars manufactured after 1980. Although this technology would be marketed toward newer cars, it does provide the ability for retrofitting older cars, provided this port is used.

Since this application is going to be created for devices with the Android OS, it will have to be designed to fit the framework of the Android User Interface so as to keep the application consistent with the Android theme. The main portion of the application is the content area, which will display all of the readings and data that the OBD sensor will gather from the car and output to the Android device. The application must also contain a main action bar, split action bar and view control with which users will be able to navigate the different views of the app content. For example, these features will be used to allow users to do things like navigate from one reading type to another, display graphical representations of the data, change the application's settings in the menu, etc. The UI is an extremely important aspect of an applications development; an app can be the most functional app on the market, but if it isn't user-friendly and easy to navigate then it won't be successful, so one of the main goals of this design will be to ensure that the app is optimized for both functionality and ease-of-use.

Another important part of this project is the communication from the OBDII to the android device using Bluetooth. Bluetooth signals will need to be sent back and forth from the android device and the OBDII Bluetooth transmitter. Using Bluetooth instead of a serial connection, or USB connection,

will allow us to free up ports on the android device which can be used for other activities and functions within the project. The device can only be communicating on one Bluetooth channel at a time. Therefore, it is very important not to allow other communications, such as Bluetooth communication between the android device and a phone, or Bluetooth audio.

Using a USB 2.0 connection allows for a high transfer rate, while using a connection that does not require host device. This allows for a simpler and sleeker design that can be universally used. This port also allows for device charging capabilities, which is perfect for the on-the-go design of the model. This USB 2.0 connectivity will also give developers the ability to troubleshoot and upgrade applications on the tablet without the need for a signal. Also, it is possible to then develop a way for mechanics to then access the OBDII diagnostics to a similar way that they would with an OBDII scanner.

A big part of this project also involves transmitting audio over the car's speakers from the android powered device. This can be achieved in a few ways, such as over Bluetooth, or by using a 3.5mm audio jack and breaking it out to the car's speakers. Due to the fact that we are using our Bluetooth communication for the OBDII port, using a 3.5mm audio jack will better suit our situation. A benefit to using a 3.5mm jack is that this can be wired to an external amplifier which will allow for higher quality audio playback.

The android tablet is a very important part of this project. A tablet that is small enough to fit into most car dashboards as well as powerful enough to handle our programs needs to be chosen. The tablet that we decided to go with is the Google Nexus 7. It is a 7 inch tablet which should be able to fit into most cars, has 1GB of RAM, and an NVIDIA Tegra 3 quad core processor. This should be enough to handle anything that we decide to run on it. Another benefit of this tablet is that is hard a fairly large hard drive, either 16 or 32 GB so we have a good amount of storage space to play with. This device also supports NFC, as well as most wireless radios which will allow us to use data on the tablet. This device is running android 4.2, or Jelly Bean, which is a very refined version of the OS with a lot of features that will benefit our production.

In addition to the performance-oriented benefits of including the Nexus 7 tablet, the ability for the owner to remove the tablet from the car is provided. This affords the operator the ability to transfer data between the tablet and his/her computer, syncing both media and performance data.

Work Breakdown

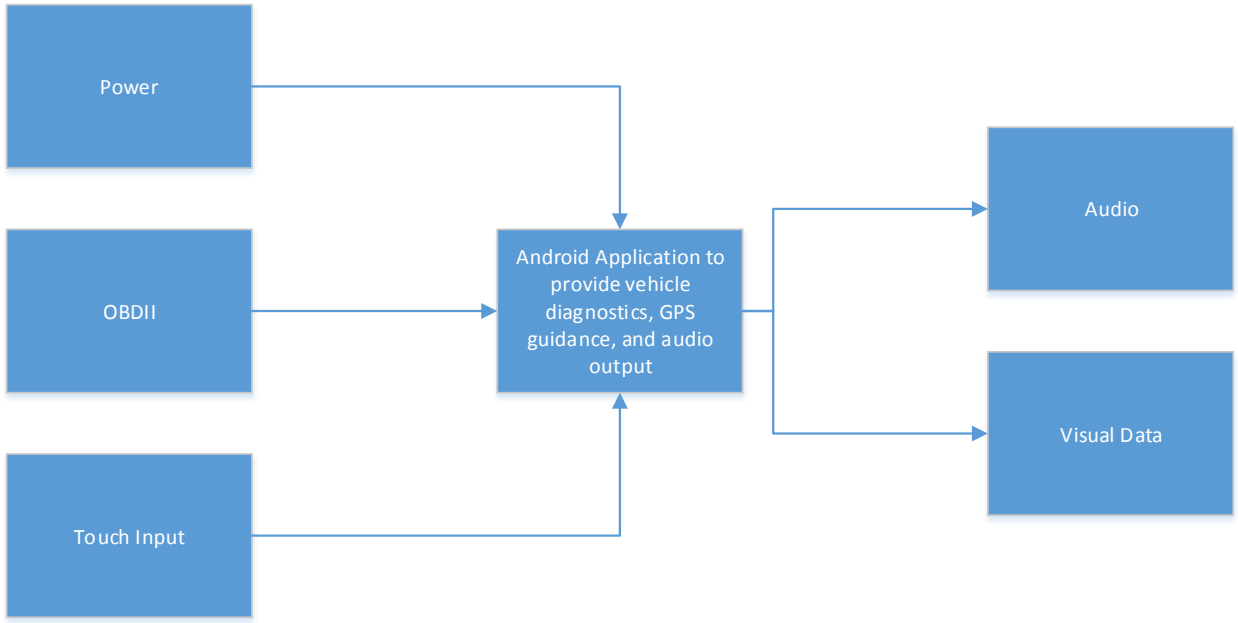
Each member of the group researched a different key aspect of the project to gain a better perspective of the finer details. The various parts in this project that were researched are as follows; Bluetooth capabilities, Android platform requirements and limitations, USB and 3.5 mm jack input specifications, and OBDII specifications. Each member was responsible for gathering a resource and explaining some significance or concern in regards to the overall design to the project. We also looked at some alternative devices and designs to open our options and possibilities. By also looking into other solutions, we are able to see a broader picture of what works well with our project design. Each member looked into tutorials and processes that would help to create the application. This involves, but is not limited to, seeing how each component connected to one another in existing applications and the uses of the individual components in devices.

After reviewing the components that could be considered for the design of this project, all the members worked together to decide how each component would function and communicate with each other. This is how we were able to construct the functional diagrams. By knowing the desired needs and relative limitations of our design, we are able to come up with multiple functional solutions. It also helps us rule out what diagrams may or may not be possible or plausible.

	Jan, Patrick	Kaminski, Gregory	Mischin, Frank	Rue, Justin
Percent Effort:	25%	25%	25%	25%

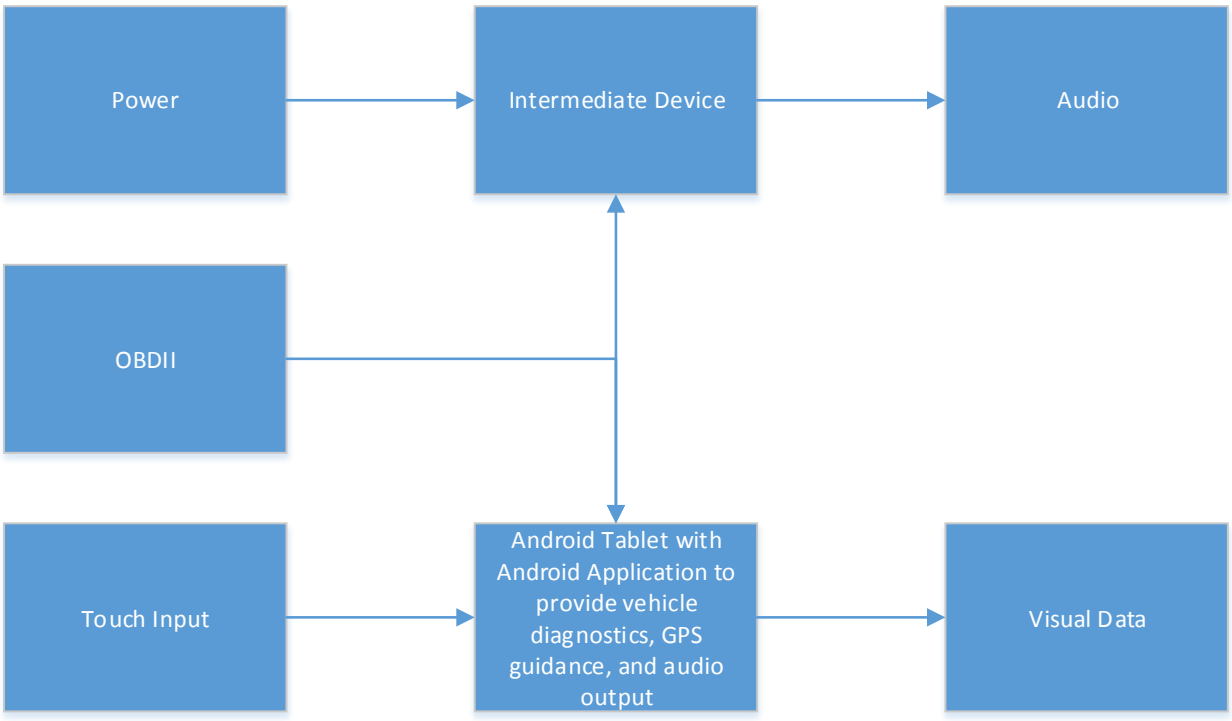
Implementation Block Diagrams

Implementation 1



In this block diagram implementation everything interfaces directly with our android powered tablet. This means that everything plugs into the tablet separately or is managed via the software. This way the power will plug directly into the charging port of the tablet. The OBDII will connect via Bluetooth to the tablet, and touch input is directly managed via the tablet's touchscreen. The audio will be retrieved via an audio cable plugged into the audio out port of our tablet, and visual data will be displayed via the touchscreen. The downfall to this approach is that the audio cable and power cable will need to be plugged in manually each time the tablet is inserted into the car.

Implementation 2



In this block diagram implementation, the power and audio connections will have an intermediate piece of hardware to connect into. This will allow the power and audio to always be connected into this intermediate device allowing for easy removal of the android tablet. This makes it much easier to install as well. The OBDII will still connect via Bluetooth and touch input and visual data output will still be interfaced through the touch screen on the tablet.

Conclusion

We feel as if implementation 2 will satisfy our requirements better. Although this may increase the cost of our device slightly, it will aid in the ease of use and security of the device. As far as performance is concerned there will be no difference due to the fact that the changes do not affect software or hardware performance at all.

Design Constraints

This project has very little concern for realistic constraints. Economically, this project can be low budget. We will have to fund the project ourselves, but aside from some wires and connections, it is mostly man power and not money that is the issue. There are affordable tablets and android products that would be able to use the application for our project. The project itself would need the android tablet product, but from a consumer standpoint, the consumer would not need to purchase an android powered device if one is already owned. This project is also designed to be used for almost any car make and model. Therefore, this project would not include the purchase of a vehicle. The other components to this project are moderately low in price, so the overall expenses of this project would be low.

We can be very cost efficient and buy a low budget tablet that runs Android or even work with an IDE environment on a laptop and splice connections into the laptop just to run tests on the prototype to ensure that the software and hardware connections work properly. Over time, we would look to use the project as a way to fund itself. Upon the initial creation of the application, we can see how useful and informative it can be, as well as how large it can be expanded. By marketing the application, we would be able to make it grow bigger to do more with alerts and interactions with servers and manage analytical data.

The environment will not pose as a huge constraint in this project. This is primarily a software project. The project can be conducted indoors so the weather conditions would not limit us. Our main goals also do not affect the environment. We would not need to meet a particular requirement or get special legislation in order to move forward. Our impacts the environment in the slightest degree.

After being used for a long time, this product could do a lot for the environment. As more drivers use this application and are more aware of the pollution and states of their cars, they can effectively drive better, save more money, and help diminish pollution.

There are no health and safety constraints in this project because most of the design in the project concerns the software design of the application. The rest is working with connecting the tablet to the rest of the car's sensors. The only concern may be the fact that the UI may be distracting since it is a touch screen application, but that is not different from systems that are already in place in vehicles.

Solutions to help with safety is incorporating voice commands to read out information or create responses within the system. This will allow the driver to stay focused on the ride while using the application. Over time, this application will help prevent any problems within the car and could even alert of problems within the system and the degree of severity.

Manufacturing should not show any constraints because there isn't any manufacturing necessary in this process. The only hands-on process with this project is installing the tablet subunit which may pose a constraint because it depends on how difficult the installation is. An easy installation will mean it could be a "Do it yourself" project, but if it is complicated, it may pose some constraints in the form of needing a professional.

As previously stated, the biggest issue would be manpower. As this project grows, it would need more people working together to allow the application to do more. More programmers building up the code and more servers to store data and information. The facility needed would only be office space.

The sustainability aspect of the project should not pose a problem. A working application will be determined by the lifespan of the tablet device and the lifespan of the sensors in the car. Ideally, the application would have the lifespan of modern software and applications with regular updates and bug fixes.

This project could have a very long lifecycle with many updates and changes. This project would be perfect for something that every driver could and should have in their vehicles. This could potentially be expanded to fit any type of vehicle to ensure better information and safety for any type of transportation, which includes public, private, and commercial travel.

Ethical and Professional Responsibilities

Once the application has been developed, the professional responsibilities of this project include taking the necessary steps to get the app on the Google Play Store for widespread distribution. But before it can be distributed, we will have to ensure that we do not infringe upon any patents or existing ideas, as well as protecting our own ideas and progress.

There really aren't many ethical responsibilities for this project. Since it's an Android application that will be sold on Google Play, the main issue is to set a fair and reasonable price for the app so as not to try and rip off the consumers who will be purchasing the application.

Although this project doesn't raise any considerable ethical questions, it does have the potential to risk the safety of its end-users. Since this project is designed for use in automobiles, it does provide a distraction to the driver when in use. For this reason, the project will be designed with safety and ease-of-use in mind. While it is impractical to totally prevent the user from operating the device while driving, safeguards will be implemented to make the head unit easy to operate. This means the driver can devote less attention to operating the unit, and more attention to operating the vehicle.

Multidisciplinary Teamwork Planning

This project depends on the knowledge of electrical, computer, and mechanical engineers. Electrical engineers and computer engineers are necessary in order to ensure the system displays relevant information, obtains this information effectively, and displays the information in a user-friendly manner. Mechanical engineers will be necessary in order to ensure the tablet mounting hardware is designed and manufactured so as to make operation of the unit as simple as stable as possible.

SWOT Analysis

Strengths

Probably the biggest strength of this product is that as of now there is currently no other form of software or hardware that goes into this much detail in terms of integrating a tablet-like interface into a vehicle. All other devices that have been used are installed in an impractical way. For example, they do not wire into the car's OBD2, as well as the antennae, which means that the device needs some sort of external power source to keep the device on. Our product will receive power as soon as the car is turned on. Due to the fact that other devices similar to ours are not actually "installed" in the vehicle, but mounted instead, our product provides a much cleaner and visually appealing install. Due to the fact that our product involves a software application as well as hardware, these products can be marketed separately as well. This means that our application can be purchased off of the Android market in order to use in their own projects, or their own modifications.

Weaknesses

One weakness of this project is that many people may not need or want this sort of device in their car. Since an Android tablet serves as the main interface, the user will be interacting via touch screen, which some people may not care for. In addition, similarly to getting navigation installed in a car, many people choose to opt out in order to save money. Also, older people who have had little to no experience with an Android OS or tablet may be very confused at first and may prefer not to use this product at all.

Opportunities

The big opportunity of this project is that it is adaptable and can always change. In this age of technology, new and improved software and hardware are constantly being released, which can be utilized to make this project even better. Eventually this product can be expanded into some sort of open source device, allowing people to really fine tune their product. Android OS is a constantly evolving software which means that our product is also constantly evolving. Another huge opportunity for this product is that it can be provided to car dealers in the same way that standard navigation units are. This means that our product can hit a much larger market than just a standalone device.

Threats

A potential threat to this project is the installation process. Wiring the device into the car's power and antenna means that our product requires some knowledge of a car's wiring harness, or the help of professional installation. This means that installing this product into an already purchased vehicle may become too expensive for most people's budgets. Another threat is that due to the fact that this device is based on existing hardware as well as an existing platform software, this device can be replicated with the proper knowledge. Something that can also be seen as a threat is that this device is similar to a cell phone in that driving while use is extremely dangerous and is something that we will need to spend a large amount of time in order to prevent.

Appendix

Bluetooth 4 Specification

https://www.bluetooth.org/Technical/Specifications/adopted.htm

USB 2.0 (High Speed) Specification

http://www.usb.org/developers/docs/usb_20_110512.zip

USB 3.0 (Super Speed) Specification

http://www.usb.org/developers/docs/usb_30_spec_021813.zip

Android Development Specifications

http://developer.android.com/guide/components/fundamentals.html#Manifest

Android UI Specifications

http://developer.android.com/design/get-started/ui-overview.html

Google Nexus 7 Tablet Specifications

http://www.google.com/nexus/7/specs/

EPA OBD Outline

http://www.epa.gov/obd/